

Overview of the SMS (v11.0), Coastal Modeling System, and User Resources



Mitchell Brown

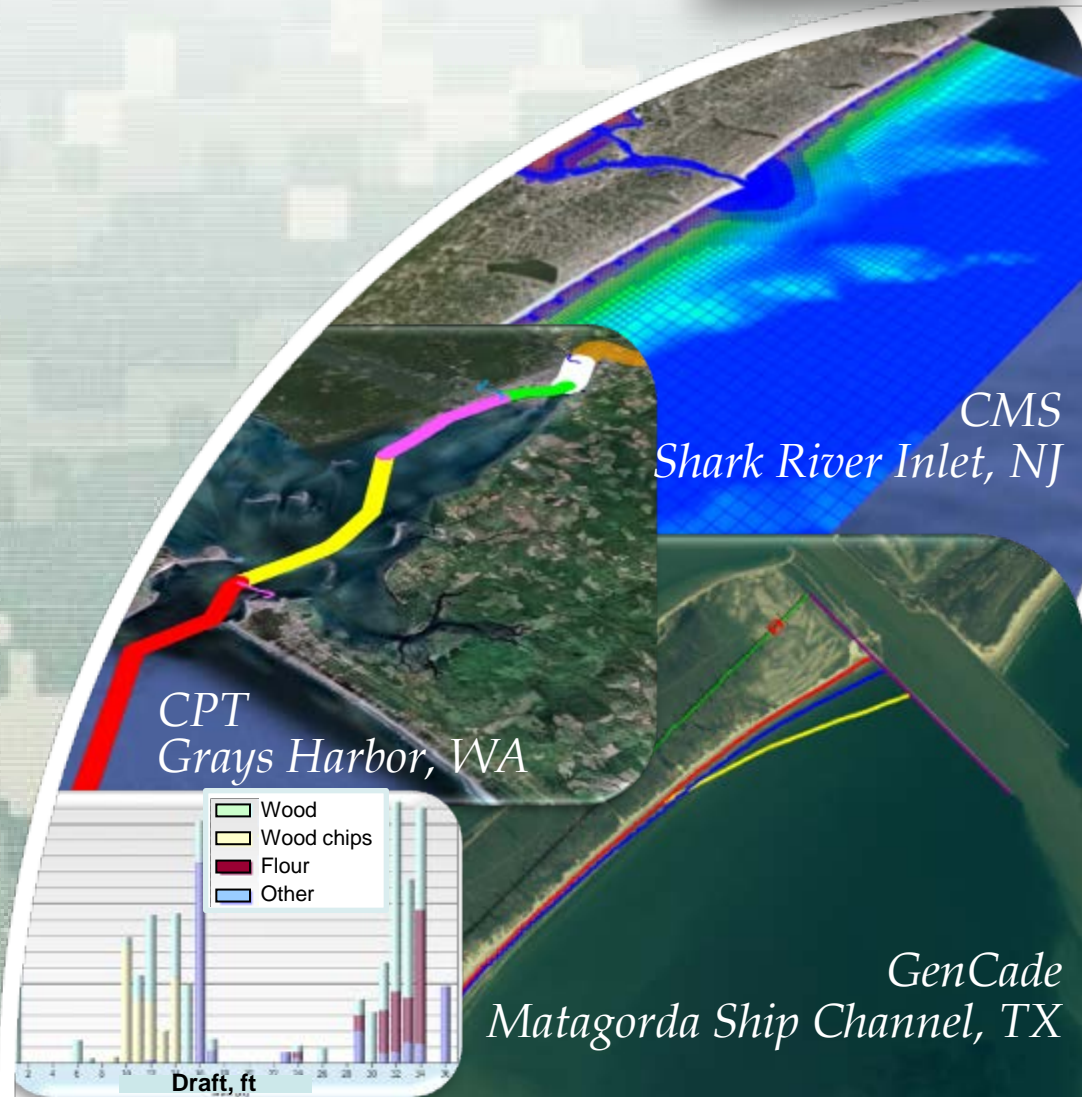
Civil Engineering Technician

Mitchell.E.Brown@erdc.dren.mil

June 11-15, 2012



US Army Corps of Engineers
BUILDING STRONG



Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE JUN 2012		2. REPORT TYPE		3. DATES COVERED 00-00-2012 to 00-00-2012	
4. TITLE AND SUBTITLE Overview of the SMS (v11.0), Coastal Modeling System, and User Resources				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Corps of Engineers,U.S. Army Engineer Research and Development Center,3909 Halls Ferry Road,Vicksburg,MS,39180-6199				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES 1st CMS Webinar, Coastal Inlets Research Program, June 11-15, 2012.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 23	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



Overview of Presentation



- Introduction to the Coastal Modeling System (CMS)
 - CMS-Flow – Hydrodynamics, Sediment Transport, Morphology Change
 - CMS-Wave – Half-plane waves and Full-plane wind forcing.





Objective

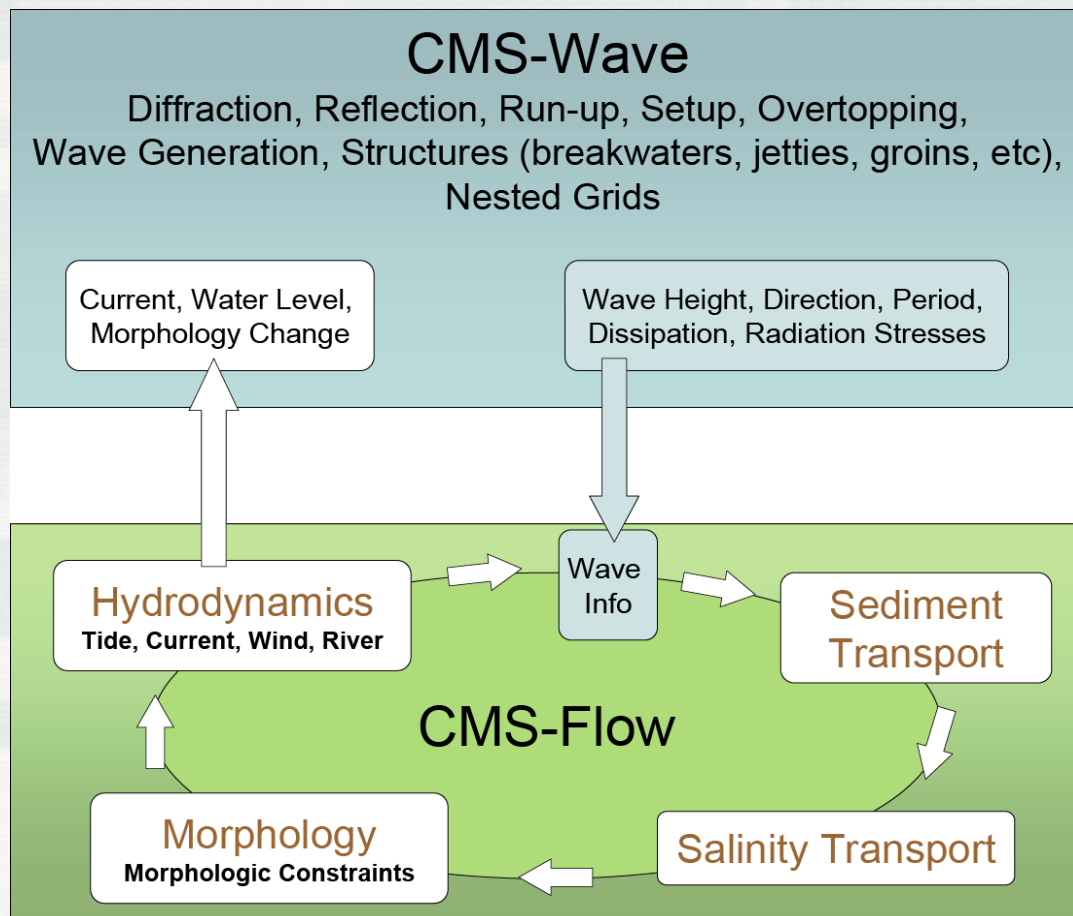


- **Deliver** to engineers' desktops **integrated** advanced models that can be used as **practical** engineering tools for **coastal** inlet and adjacent beach studies.
 - Integrated: All relevant processes, models efficiently coupled together
 - Practical: PC-based, user-friendly interface, fast, robust and accurate
 - Deliver: Manuals, tech reports, journal papers, Wiki, workshops, phone help, etc.





CMS Overview



Since 1997...

- **2 webinars**
- **38 workshops**
- Districts can independently run the CMS!

Advantages...

- Robust
- Physics-based
- Integrated SYSTEM
- In SMS
- User-friendly



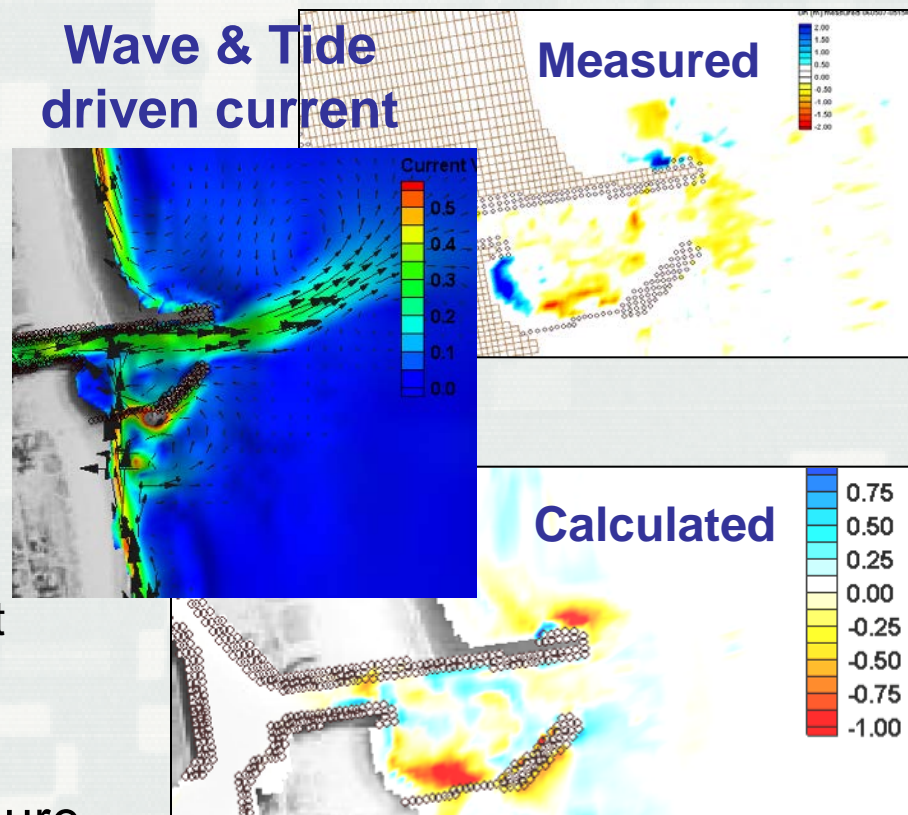


CMS-Flow Key Features



- Finite Volume Method
 - Conserves mass
 - Stable
 - Accessible
- Coupled with spectral wave model (CMS-Wave)
 - Wave-current interactions
- Inline sediment transport and morphology change
 - Non-equilibrium sediment Transport model (NET)
- Nesting capability
- WSE, river, wind/atmospheric pressure forcing
- Tidal constituent forcing (**NEW**)

**Wave & Tide
driven current**

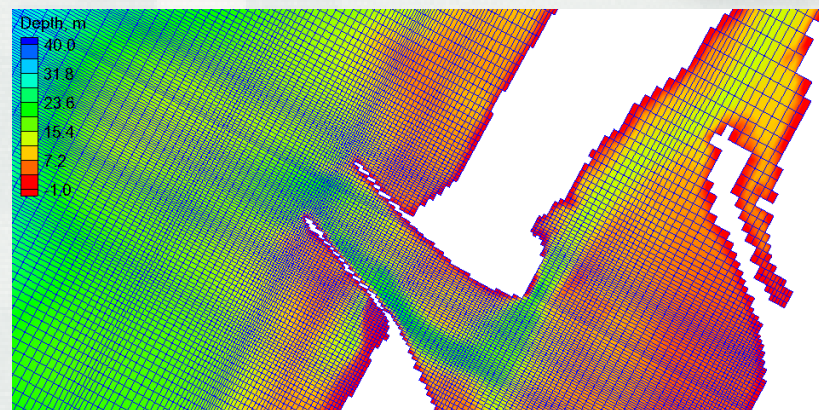




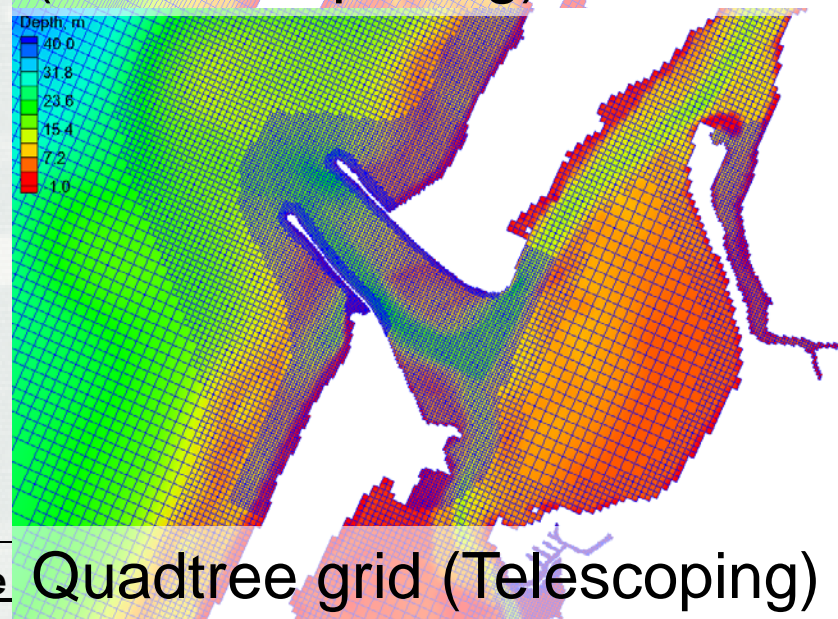
CMS-Flow Key Features



- Grid options
 - Non-uniform Cartesian grid: Easy to setup
 - Quadtree (telescoping) grid: Efficient, flexible (presently, only available for Implicit model)
- Solver options
 - Implicit: Tidal flow, long-term morphology change, parallel processing.
~5 - 30 minute time step
 - Explicit: Flooding, breaching, super-critical flow. ~1 second time step, parallel processing



Non-uniform Cartesian grid
(Variable spacing)



Quadtree grid (Telescoping)



Hydrodynamics



Included terms for the depth-averaged shallow water equations in Cartesian coordinates

Depth - averaged current velocity

Total water depth

Still water depth

Water surface elevation

Gravity

Atmospheric Pressure

Precipitation / Evaporation

Coriolis

Turbulent eddy viscosity

Bottom stress (including waves)

Wave stress (forcing)

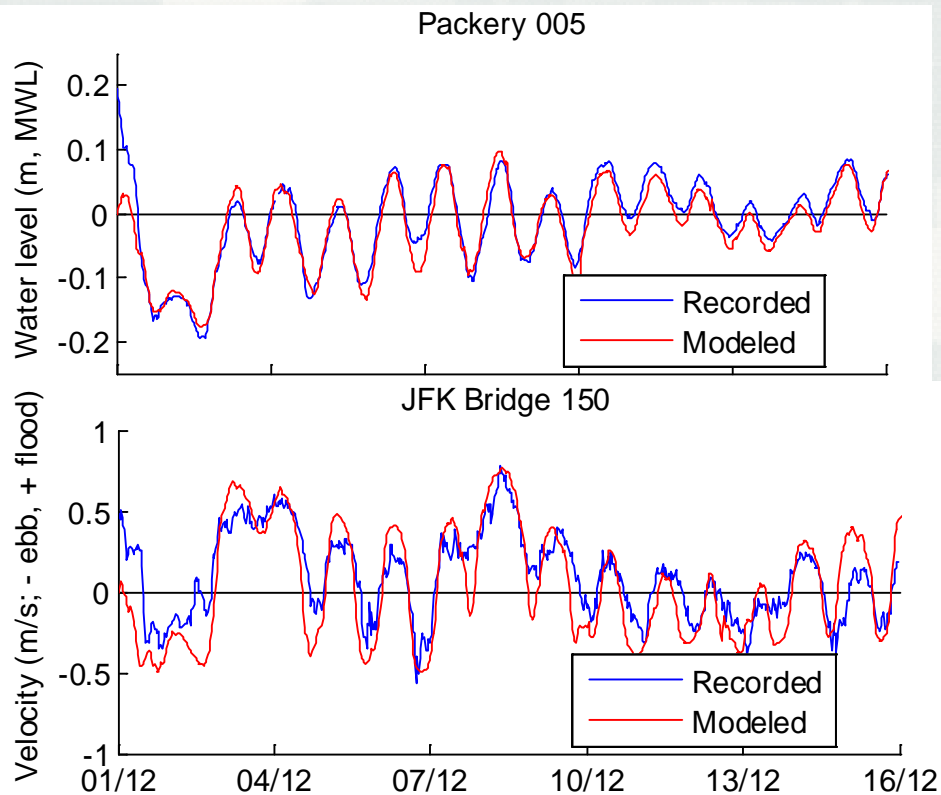
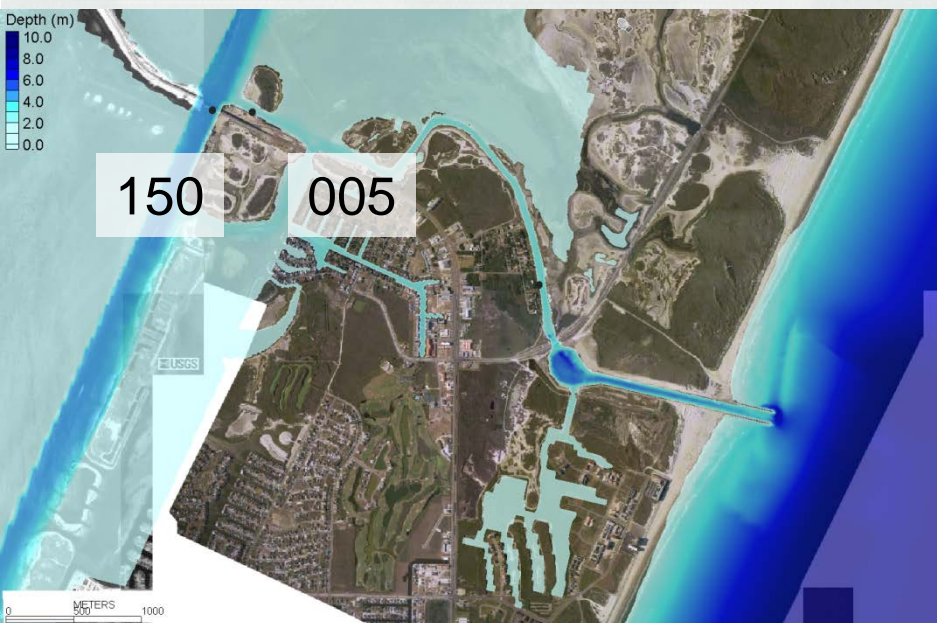
Wind stress





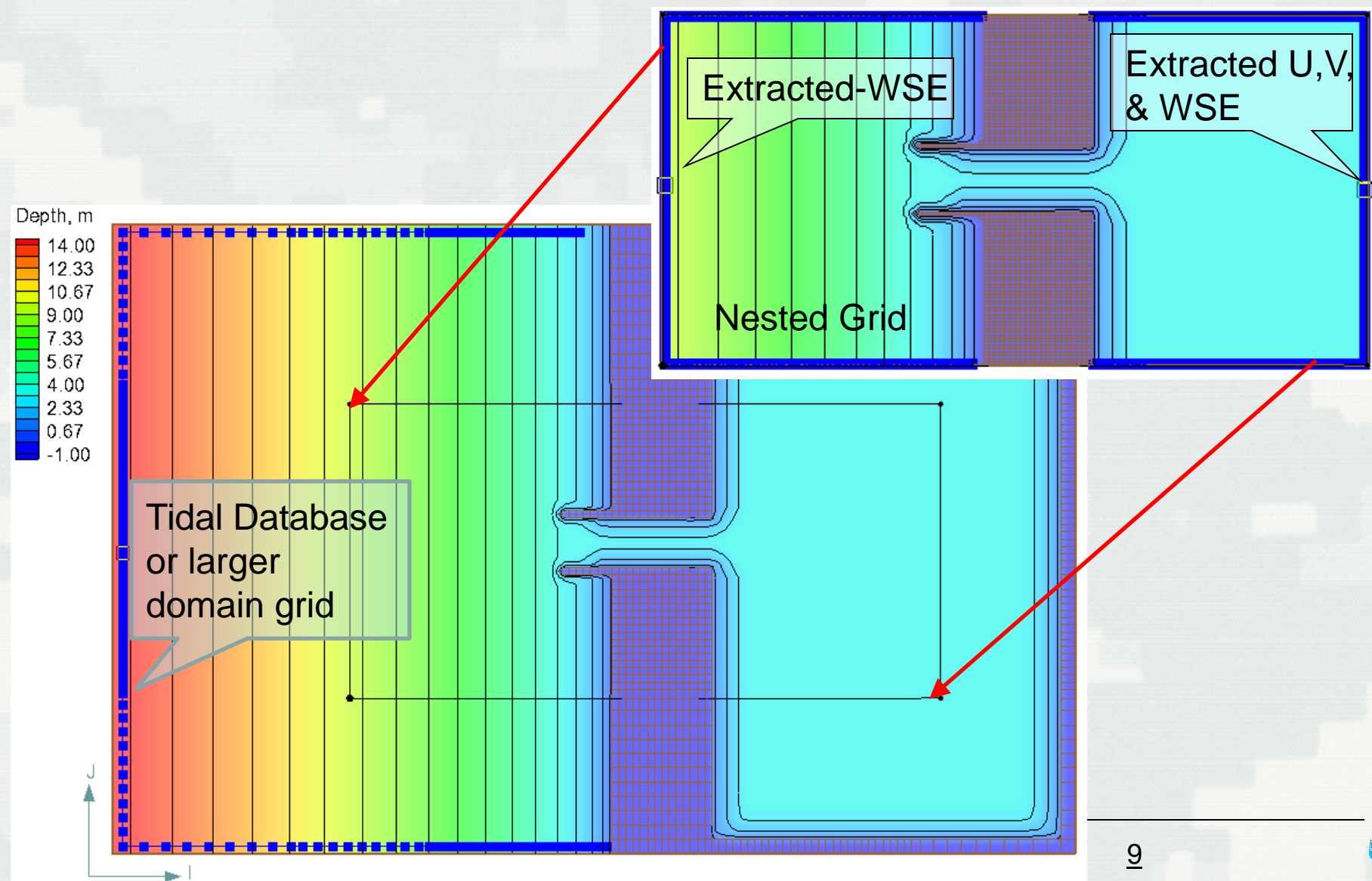
®

Packery Channel, TX





Nested Grid Capability

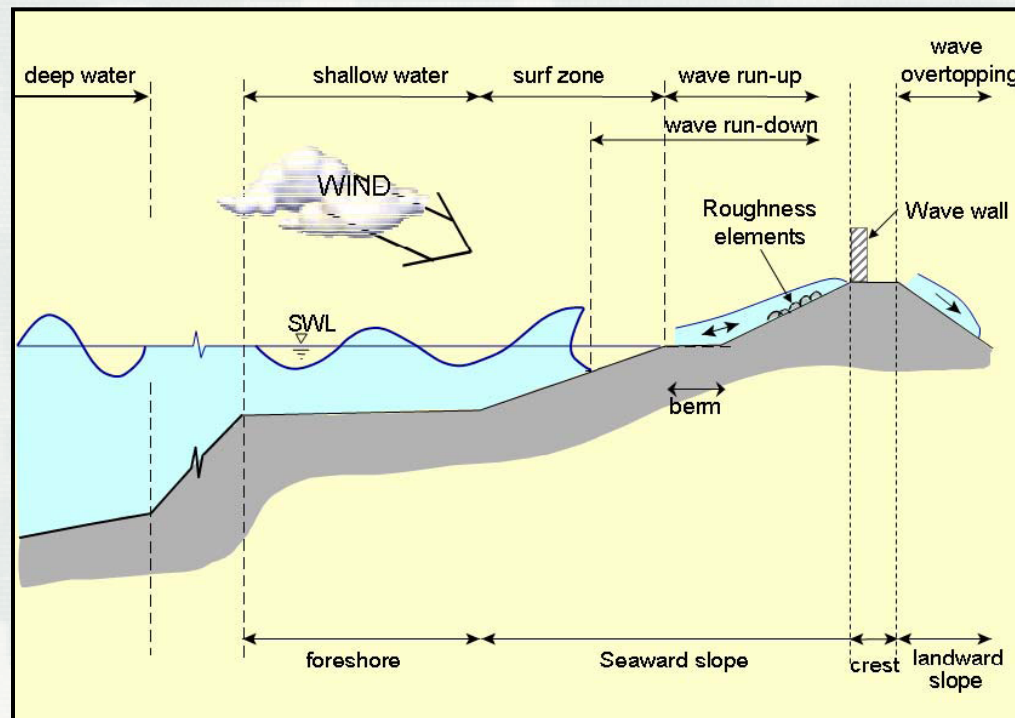




CMS-Wave: Key Features



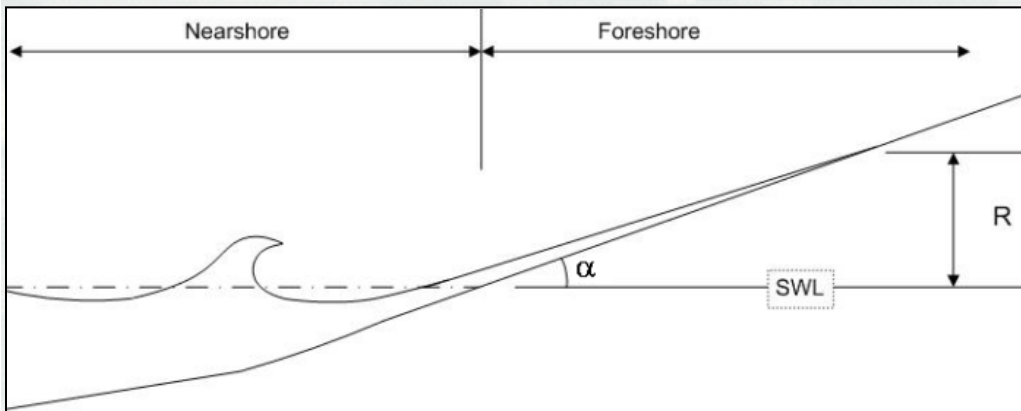
- Shoaling, refraction, diffraction, reflection
- Bottom friction
- White capping
- Wave breaking (4 options)
- Wind generation
- Wave-current, and wave-wave interactions
- Transmission, runup and overtopping
- Muddy bottom
- Automatic grid rotation
- Non-uniform Cartesian grid with nesting capability
- “Fast Mode”





®

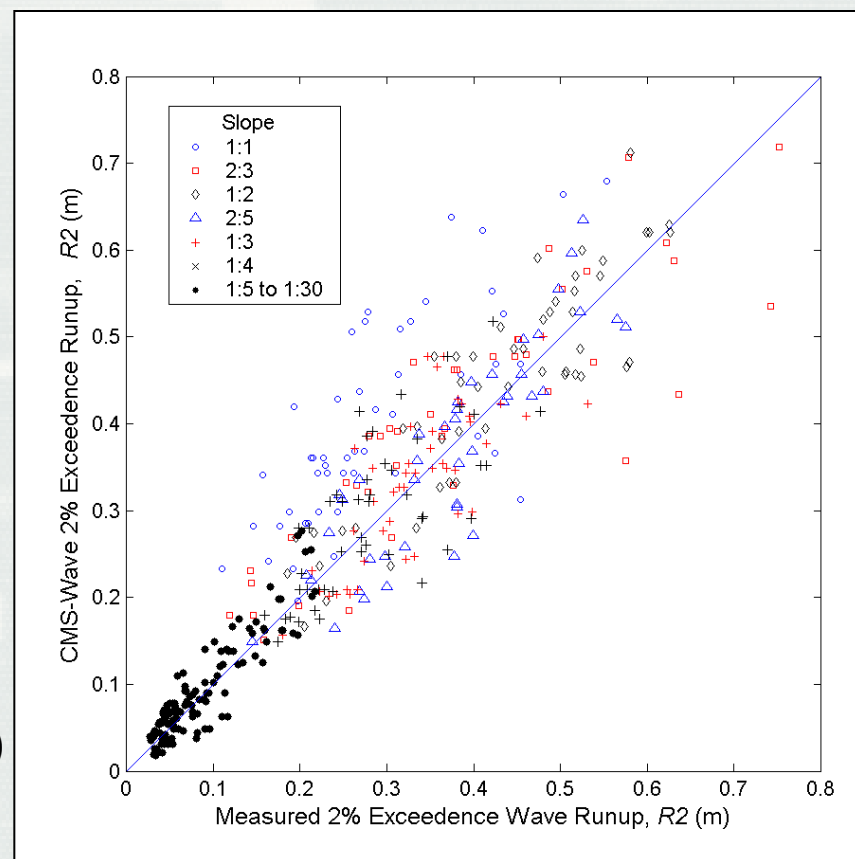
Wave Run-up



Wave run-up: rush of waves up a slope or structure

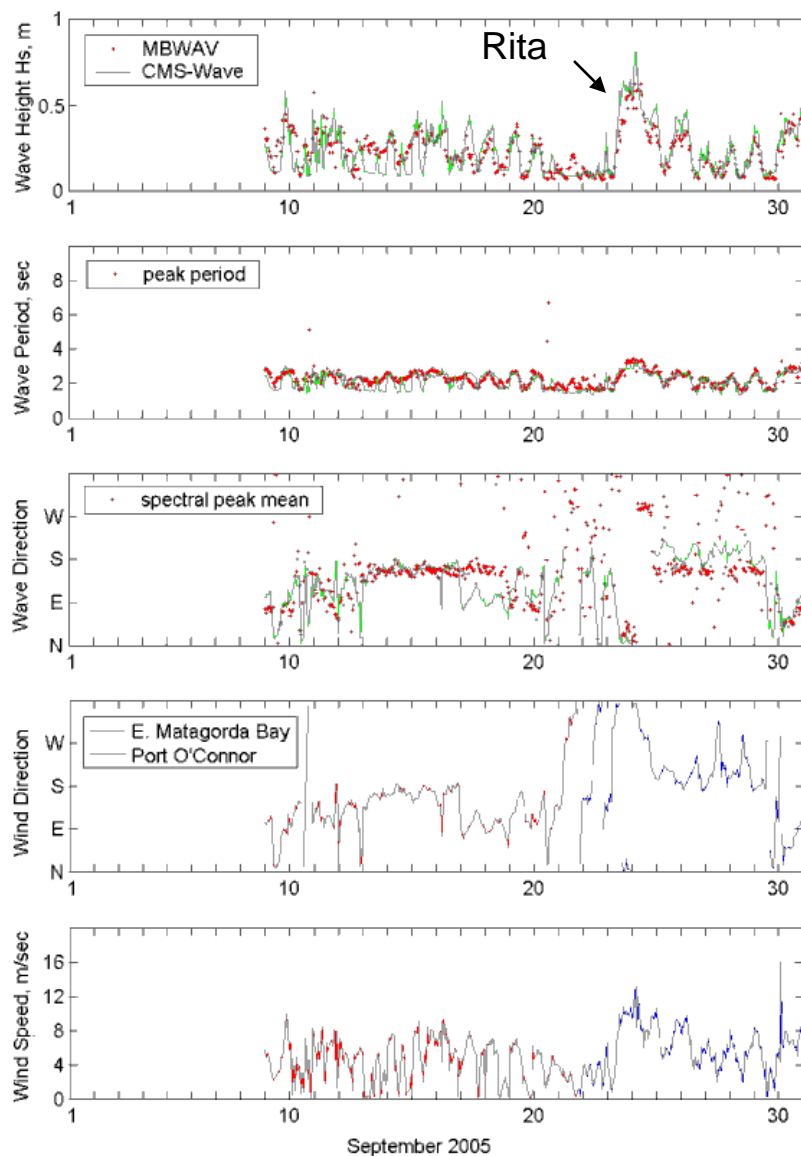
Two-percent run-up, R_2 : the vertical up-rush level exceeded by 2-percent of the larger run-up height

**Ahrens & Titus (1981), Mase & Iwagaki (1984)
~ 400 laboratory experiments**

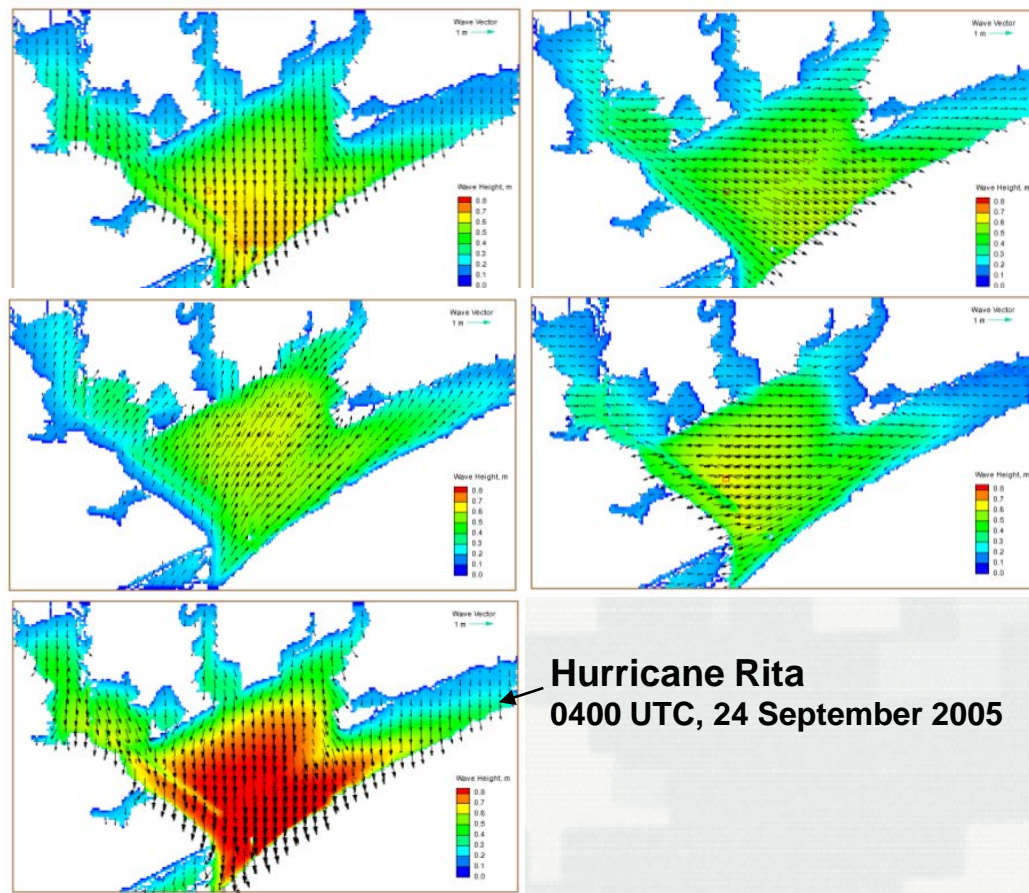




Wave Generation



Matagorda Bay, TX



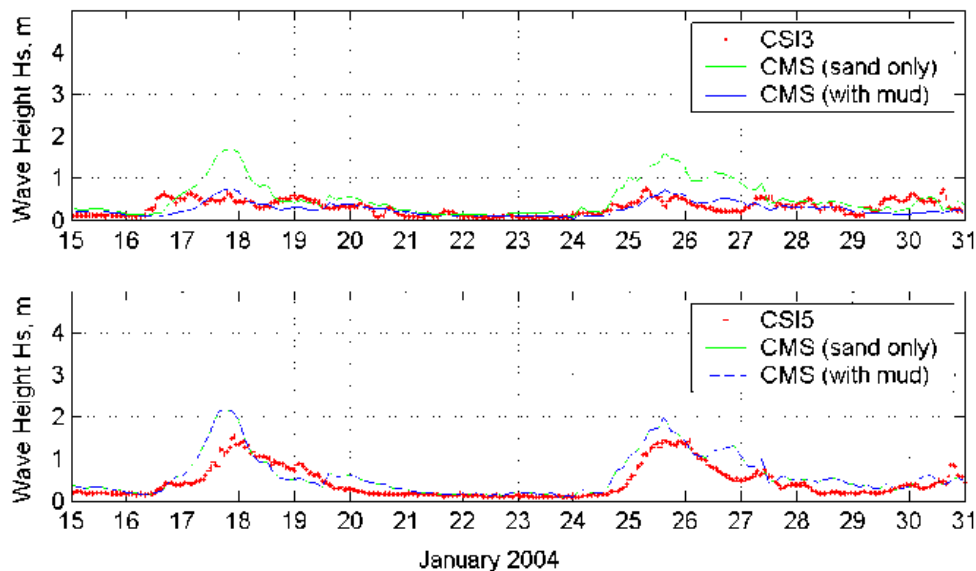
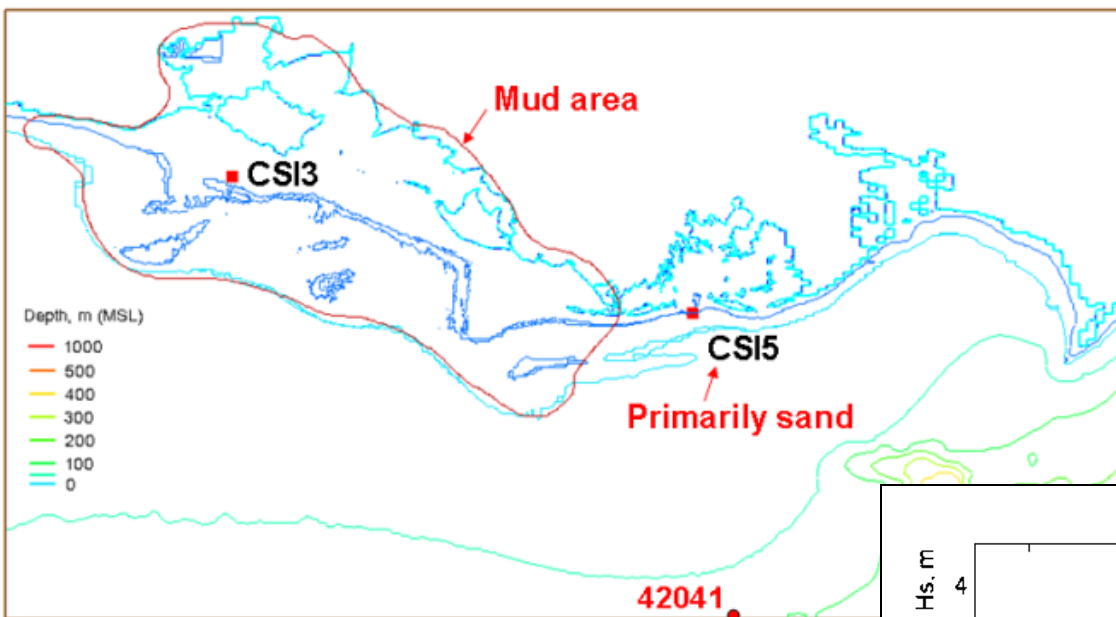
Hurricane Rita
0400 UTC, 24 September 2005





®

Wave Dissipation over Muddy Coast

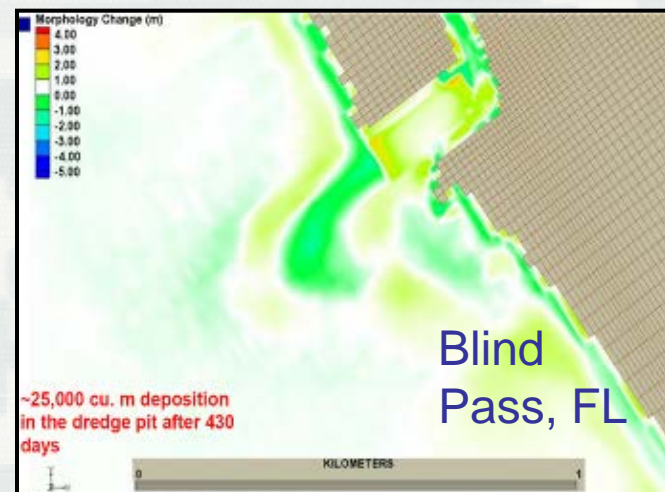
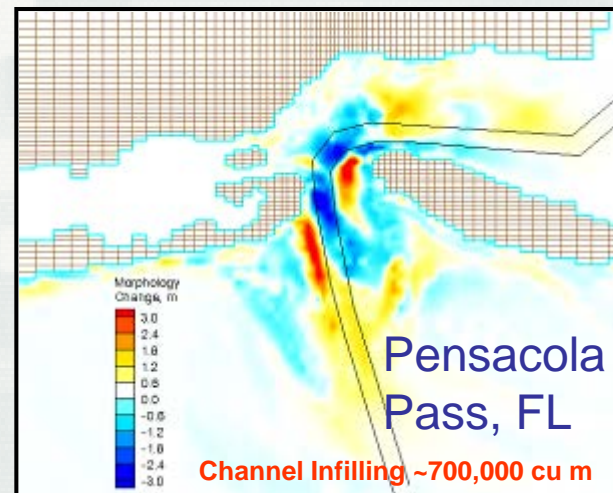




Sediment Transport: Key features

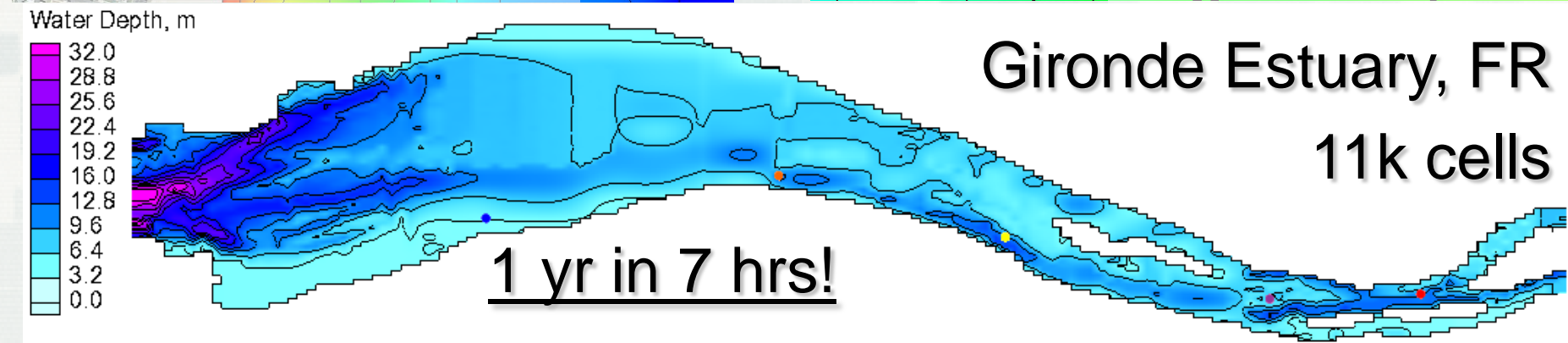
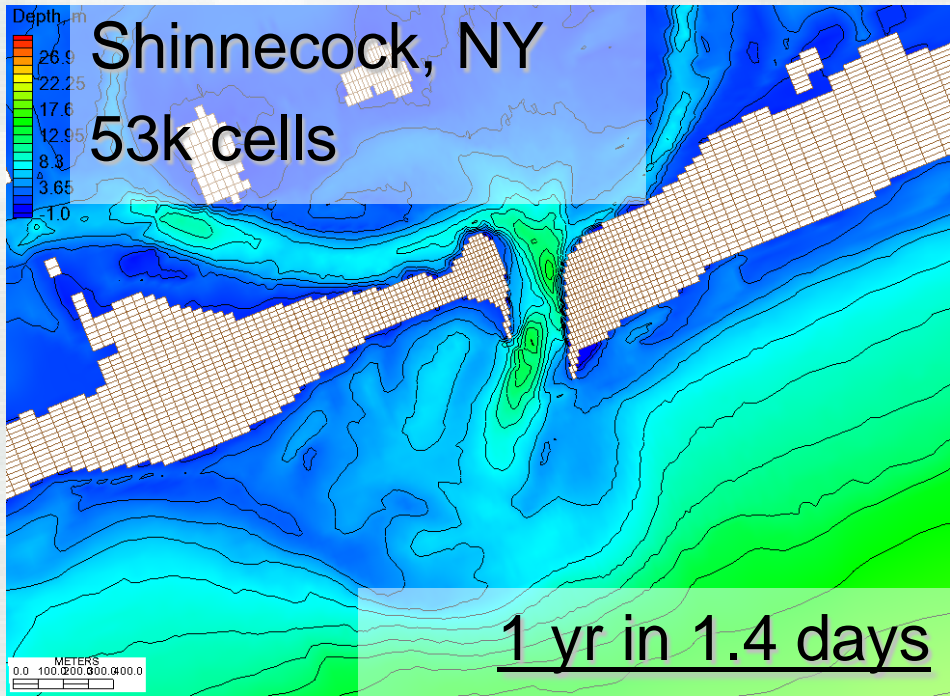
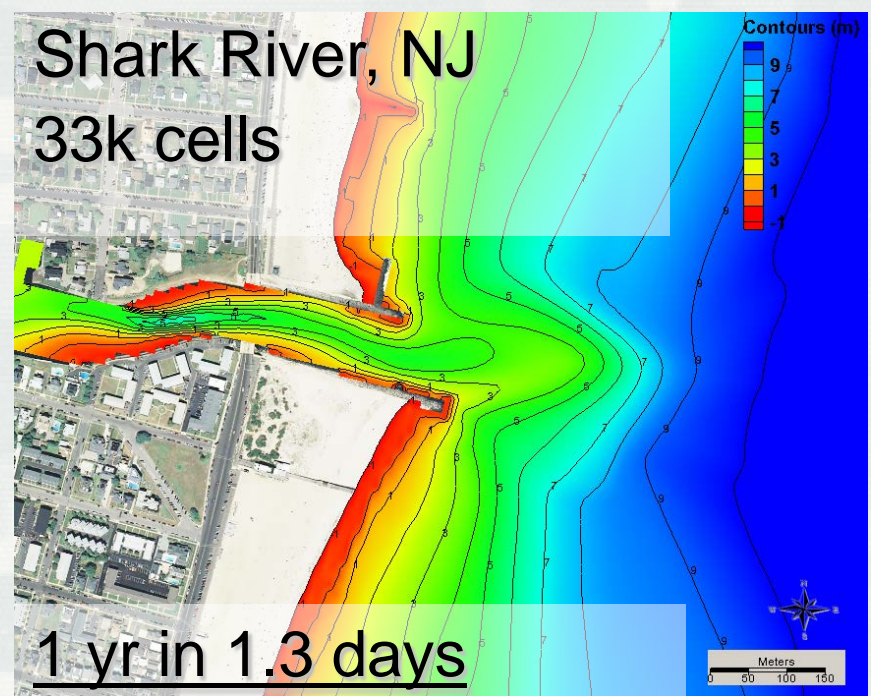


- Sediment transport models
 - Equilibrium Total Load (Exner equation)
 - Eq. Bed Load + Advection-Diffusion (AD) Suspended Load
 - Non-Eq. (AD Total Load)
- Sediment transport formulas
 - Lund-CIRP
 - Van Rijn
 - Watanabe
 - Soulsby
- Hard-bottom
- Avalanching
- Bed slope influence on bed load
- Multiple-sized sed. transport (**NEW**)





Computational Speed (Implicit)



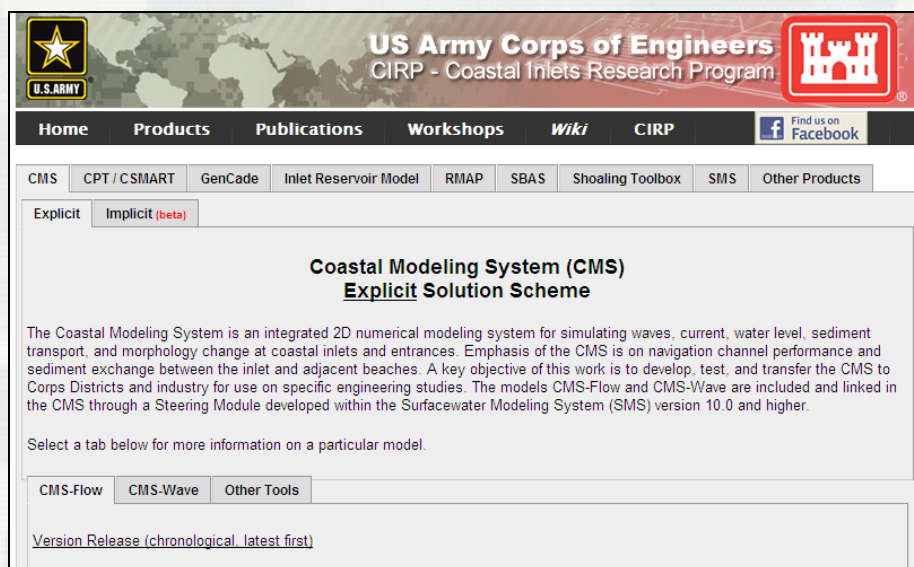


Documentation

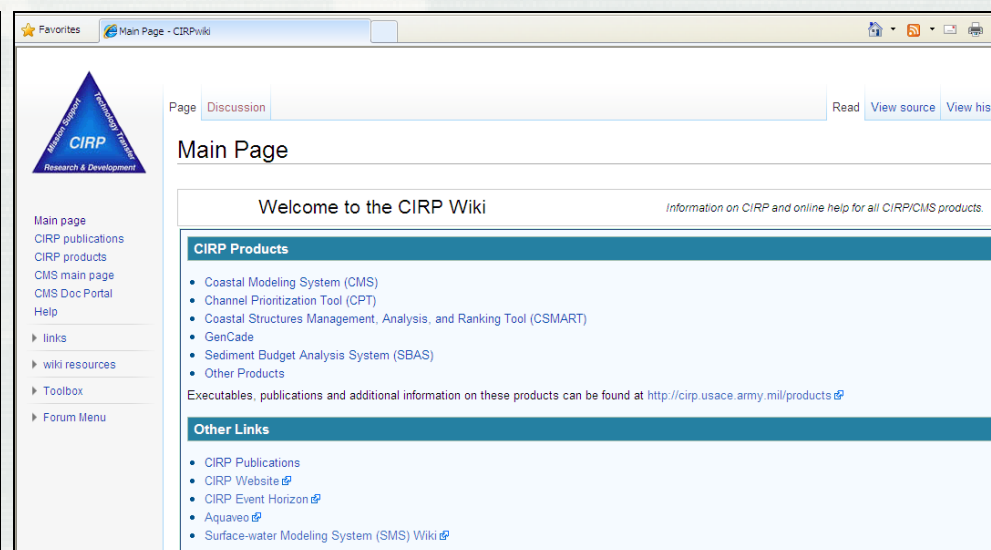


■ CIRP website

■ CIRP Wiki



The screenshot shows the CIRP website homepage. At the top is the US Army Corps of Engineers logo and the text "US Army Corps of Engineers CIRP - Coastal Inlets Research Program". Below this is a navigation bar with links: Home, Products, Publications, Workshops, Wiki, and CIRP. A "Find us on Facebook" link is also present. The main content area features a "Coastal Modeling System (CMS) Explicit Solution Scheme" section. It includes a description of the CMS as an integrated 2D numerical modeling system for simulating waves, current, water level, sediment transport, and morphology change at coastal inlets and entrances. Below the description is a "Select a tab below for more information on a particular model." section with tabs for "CMS-Flow", "CMS-Wave", and "Other Tools". A "Version Release (chronological, latest first)" link is also visible.



The screenshot shows the CIRP Wiki Main Page. It features a "Welcome to the CIRP Wiki" message with a link to "Information on CIRP and online help for all CIRP/CMS products." Below this is a "CIRP Products" section listing several tools: Coastal Modeling System (CMS), Channel Prioritization Tool (CPT), Coastal Structures Management, Analysis, and Ranking Tool (CSMART), GenCode, Sediment Budget Analysis System (SBAS), and Other Products. A link is provided to find executables, publications, and additional information on these products. Below the products list is an "Other Links" section with links to CIRP Publications, CIRP Website, CIRP Event Horizon, Aquaveo, and Surface-water Modeling System (SMS) Wiki.

<http://cirp.usace.army.mil/>

<http://cirp.usace.army.mil/wiki/>





Documentation Website



■ Products

- CMS
- GenCade
- Others

■ Publications

- Technical Reports
- CHETNS
- Journal Articles
- Others

■ Tech Transfer

- Upcoming
- Recent

US Army Corps of Engineers
CIRP - Coastal Inlets Research Program

Home Products Publications **Tech Transfer** Wiki CIRP Search

Webinars
Workshops
Meetings

US Army Corps of Engineers

CIRP
Research & Development

13th Annual
CIRP Technology-Transfer Workshop (#38)
6-8 March 2012
Philadelphia District
US Army Corps of Engineers

The 13th Annual Coastal Inlets Research Program (CIRP) Technology Transfer Workshop (38th overall) will be held in March 2012. The workshop will be held using facilities at the Philadelphia District. Workshop attendees will be provided Laptops or PCs with pre-loaded software, a bound notebook with presentations, and a link to download all software and data sets prior to the conference. A temporary 60-day license* for the Surface-Water Modeling System (SMS) including the Coastal Modeling System (CMS), and GenCade.

NEW - Webinar Information

Most of the Workshop will also be set up as a Webinar (call-in and connection information below). If you are interested in participating in the workshop via webinar, please email Julie.D.Rosati@usace.army.mil so we can let you know where workshop materials are posted beforehand and add your name to our list. You are welcome to participate for any portions of the workshop in which you have interest.

It is likely to be difficult for us to respond to individual off-site questions during the workshop, but we will respond to you each as time allows, so please use the webinar "participant chat" option for questions as these arise. Or, as always, feel free to email workshop instructors anytime.

Webinar access and call-in information:
Toll-Free #: 888-273-3658
Participant Code: 6760180

Webinar: <https://www.webmeeting.att.com> (Internet Explorer works best). The Meeting Number is the same at the phone number as listed above. The Participant Code is the same as above.





Documentation Wiki



- CMS
 - Documentation Portal
 - Tutorials
 - Technical Info (Equations)
 - Validation Cases
- Gencade
 - Information
 - User Guide
- CPT/CSMART
 - Information and Guidance

Channel Portfolio Tool (CPT)

POC: Dr. Kenneth Ned Mitchell
Kenneth.n.mitchell@usace.army.mil
601-634-2022

US Army Engineer Research and Development Center (ERDC)
Coastal and Hydraulics Lab (CHL)

Active URL (Corps machines only): <https://itlgis01.usace.army.mil/CPTWeb/> 🗝

CPT is developmental software that is updated frequently.

CPT general layout

Setting the level of analysis (Reach, Project, District, Division)

CPT is designed to enable analysis of commercial utilization of the Corps-maintained waterway infrastructure at a variety of coverage levels. At the most detailed level, individual channel sub-reaches may be chosen for analysis and compared to other sub-reaches in the USACE portfolio of navigation projects. However, in order to provide decision support to personnel at all levels of Corps management, CPT can also be used to analyze and compare commercial usage figures at the Project, District, and Division levels. For example, a District program manager might want to see which navigation project under his or her control handles the most exports of a particular commodity. CPT pulls from a large database that is maintained by the Corps' Waterborne Commerce Statistics Center (WCSC). Setting the desired level of analysis is done through the CPT Home screen: <https://itlgis01.usace.army.mil/CPTWeb/> 🗝. Figure 1 shows the four levels of analysis provided by CPT; the desired level is chosen by simply clicking on the respective link.





Reports and Tech Notes

- Demirbilek, Z., K. J. Connell, N. J. MacDonald, and A. K. Zundel. 2008. **Particle Tracking Model in the SMS 10: IV. Link to Coastal Modeling System**, Coastal and Hydraulics Engineering Technical Note ERDC/CHL CHETN-IV-71. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
- Brown, M. E., and N. C. Kraus. 2007. **Tips for developing bathymetry grids for Coastal Modeling System Applications**, Coastal and Hydraulics Laboratory Engineering Technical Note ERDC/CHL CHETN-IV-69. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
- Buttolph, A. M., Reed, C. W., Kraus, N. C., Ono, N., Larson, M., Camenen, B., Hanson, H., Wamsley, T., and Zundel, A. K. 2006. **Two-Dimensional Depth-Averaged Circulation Model CMS-M2D: Version 3.0, Report 2, Sediment Transport and Morphology Change**, Technical Report ERDC/CHL-TR-06-7, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, Mississippi.
- Lin, L., Z. Demirbilek, H. Mase, J. Zheng., and F. Yamada. 2008. **CMS-Wave: A Nearshore Spectral Wave Processes Model for Coastal Inlets and Navigation Projects**. ERDC/CHL TR-08-13.
- Lin, L., H. Mase, F. Yamada, and Z. Demirbilek. 2006. **Wave-Action Balance Equation Diffraction (WABED) Model: Tests of Wave Diffraction and Reflection at Inlets**. ERDC/CHL CHETN-III-73.





Publications: Sediment Transport



- Sánchez, A., and Wu, W. 2011. **"A Non-equilibrium Sediment Transport Model for Coastal Inlet Applications"**. *Journal of Coastal Research*, in press.
- Camenen, B., and Larson, M., 2008. **"Equivalent Roughness Height for Plane Bed Oscillatory Flow,"** *Estuarine, Coastal, and Shelf Science*, Vol 81, pp 409-422.
- Camenen, B., and Larson, M., 2008. **"A General Formula for Non-Cohesive Suspended Sediment Transport,"** *Journal of Coastal Research*, Vol 24, No. 3, pp 615-627.
- Camenen, B., and Larson, M. 2007. **"A Unified Sediment Transport Formulation for Coastal Inlet Application,"** Contract Report ERDC/CHL-CR-07-1, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, Mississippi.
- Camenen, B., and Larson, M. 2007. **"A Total Load Formula for the Nearshore,"** *Proceedings Coastal Sediments '07 Conference*, ASCE Press, Reston, VA, 56-67.
- Hanson, H., and Camenen, B. 2007. **"Closed Form Solution for Threshold Velocity for Initiation of Sediment Motion Under Waves,"** *Proceedings Coastal Sediments '07 Conference*, ASCE Press, Reston, VA, 15-27.
- Camenen, B. and Larson, M., 2006. **"Phase Lag Effects in Sheet Flow Transport,"** *Coastal Engineering*, Vol 53, pp 531-542.
- Camenen, B., Bayram, A., and Larson, M., 2006. **"Equivalent Roughness Height for Plane Bed Under Steady Flow,"** *Journal of Hydraulic Engineering*, Vol 132, No. 11, pp 1146-1158.
- Gravens, M. B., and Wang, P. 2007. **"Data Report: Laboratory Testing of Longshore Sand Transport by Waves and Currents; Morphology Change Behind Headland Structures,"** Technical Report ERDC/CHL-TR-07-8, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, Mississippi.





Publications: Applications/Projects



- Beck, T.M., and Wang, P. 2009. **Influences of channel dredging on flow and sedimentation patterns at microtidal inlets, West-central Florida, USA.** Proceedings Coastal Dynamics 2009.
- Li, H., Brown, M. E., Smith, T. D., Podoski, J. H., 2009 (draft). **Evaluation of Proposed Channel on Circulation and Morphology Change at Kawaihae Harbor and Pelekane Bay, Island of Hawaii, HI,** Technical Report ERDC/CHL-TR-XX-XX, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, MS.
- Seabergh, W.C., Smith, E.R., and Rosati, J.D. 2009 (draft). **Sabine-Neches Waterway, Sabine Pass Jetty System: Past and Future Performance,** ERDC/CHL-TR-09-X, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, MS
- Demirbilek, Z., Lin, L., and Nwogu, O. G. 2008. **Wave Modeling for Jetty Rehabilitation at the Mouth of the Columbia River, Washington/Oregon, USA,** ERDC/CHL-TR-08-3, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, Mississippi.
- Barcak, R. G., Kraus, N. C., Lin, L., Smith, E. R., Heilman, D. J., and Thomas, R. C. 2007 **Navigation Improvement, Mouth of the Colorado River, Texas,** *Proceedings Coastal Sediments '07 Conference*, ASCE Press, Reston, VA, 1502-1514.
- Wang, P., Tidwell, D. K., Beck, T. M., and Kraus, N. C. 2007. **Sedimentation Patterns in a Stabilized Migratory Inlet, Blind Pass, FL.** *Proceedings Coastal Sediments '07 Conference*, ASCE Press, Reston, VA, 1377-1390.
- Zarillo, G. A., and Brehin, F. G. A. (2007). **Hydrodynamic and Morphologic Modeling at Sebastian Inlet, FL,** *Proceedings Coastal Sediments '07 Conference*, ASCE Press, Reston, VA, 1297-1310.
- Wamsley, T. V., Cialone, M. A., Connell, K. J., and Kraus, N. C. 2006. **Breach History and Susceptibility Study, South Jetty and Navigation Project, Grays Harbor, Washington,** ERDC/CHL-TR-06-22, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, MS.
- Hughes, S. A., and Cohen, J. 2006. **Half Moon Bay, Grays Harbor, Washington: Movable-Bed Physical Model Study,** Technical Report ERDC/CHL-TR-06-15, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, MS.





Publications: Various



- Nam, P.T., and Larson, M. 2010. **Model of nearshore waves and wave-induced currents around a detached breakwater**, *Journal of Waterway, Port, Coastal, and Ocean Engineering*, 136(3),156-176.
- Wu, W., Sánchez, A., and Mingliang, Z., 2011. **An Implicit 2-D Shallow Water Flow Model on an Unstructured Quadtree Rectangular Grid**, *Journal of Coastal Research*, in press.
- Nam, P.T., Larson, M., Hanson, H., and Hoan, L.X. 2009. **A numerical model of nearshore waves, currents, and sediment transport**, *Coastal Engineering*, 56, 1084-1096.
- Demirbilek, Z., Lin, L., Seabergh, W.C., Mase, H., and Zheng, J.I. 2009. **Laboratory and Numerical Studies of Hydrodynamics Near Jetties**, *Coastal Engineering Journal* Vol. 51, No. 2, 143-175.
- Sánchez, A. 2008. **Interactions between wetlands and tidal inlets**, Coastal and Hydraulics Engineering Technical Note. ERDC/CHL CHETN-IV-72. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
- Seabergh, W. C., Demirbilek, Z., and Lin, L. (2008). **Guidelines Based on Physical and Numerical Modeling Studies for Jetty Spur Design at Coastal Inlets**, *International Journal of Ecology & Development (IJED)*, Vol. 11, No. F08, pp 4-19.
- Zheng, J., H. Mase, Z. Demirbilek, and L. Lin. 2008. **Implementation and evaluation of alternative wave breaking formulas in a coastal spectral wave mode**. *Ocean Engineering*. Vol. 35., pp.1090-1101.
- MacDonald, N. J., Davies, M. H., Zundel, A. K., Howlett, J. D., Demirbilek, Z., Gailani, J. Z., Lackey, T. C., and Smith, J. (2006). **PTM: Particle Tracking Model; Report 1: Model Theory, Implementation, and Example Applications**, Technical Report ERDC/CHL-TR-06-20, US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, Mississippi.





Questions?

Mitch Brown

Mitchell.E.Brown@erdc.dren.mil

601-634-4036

